

Serial No. 09/824,763

LISTING OF CLAIMS:

The following listing of claims replaces all previous versions, and listings of claims in the present application.

1. (Cancelled) A load drive apparatus for switching a current supplied from a power source to a load by driving switching means, which has a switching device and a control unit for controlling a switching operation of the switching device, the load drive apparatus comprising:

- a power source terminal connected to a power source side of the power source;
- a ground terminal connected to a ground side of the power source;
- a voltage supply line connected to the power source terminal to supply a voltage to the switching device and the control unit; and
- a ground line connecting the switching device and the control unit to the ground terminal.

2. (Currently amended) The load drive apparatus as in claim 1, wherein:

- the voltage supply line connected to the power source terminal is used in common to both of the control unit and the switching device; and
- the ground line connected to the ground terminal is used in common to both of the control unit and the switching device.

3. (Currently amended) The load drive apparatus as in claim 1, wherein:

- the switching means includes a plurality of parallel-connected switching circuits, each of which has the switching device and the control unit, to drive in parallel the plurality of switching circuits;
- the voltage supply line is connected in common to the control unit and the switching device of each of the switching circuits; and
- the ground line is connected in common to the control unit and the switching device of each of the switching circuits.

4. (Currently amended) The load drive apparatus as in claim 1, wherein:

Serial No. 09/824,763

the switching means includes a plurality of parallel-connected switching circuits, each of which has the switching device and the control unit, to drive in parallel the plurality of switching circuits;

the voltage supply line is connected to the power source terminal to supply the voltage to the control unit and the switching device of each of the switching circuits; and

the ground line is connected to the ground terminal, and the control unit and the switching device of each of the switching circuits.

5. (Currently amended) ~~The load drive apparatus as in claim 1, further comprising:~~

A load drive apparatus for switching a current supplied from a power source to a load by driving switching means, which has a switching device and a control unit for controlling a switching operation of the switching device, the load drive apparatus comprising:

a power source terminal connected to a power source side of the power source;

a ground terminal connected to a ground side of the power source;

a voltage supply line connected to the power source terminal to supply a voltage to the switching device and the control unit;

a ground line connecting the switching device and the control unit to the ground terminal;

a first capacitor connected between the power source terminal and the ground terminal;
and

a first resistor connected in series with the first capacitor.

6. (Cancelled) The load drive apparatus as in claim 1, further comprising:

an input terminal provided so that an input signal is inputted from an external side and the switching means controls ON and OFF conditions of the switching device based on the input signal applied to the input terminal.

7. (Cancelled) The load drive apparatus as in claim 6, wherein:

the control unit has a first comparator to compare the input signal applied to the input terminal and a predetermined voltage preset with the voltage of the power source; and

Serial No. 09/824,763

the first comparator outputs a control signal to turn off the switching device when the input signal applied to the input terminal is higher than the predetermined voltage.

8. (Cancelled) The load drive apparatus as in claim 7, further comprising:
a second resistor connected between the input terminal and the power source terminal.

9. (Currently amended) ~~The load drive apparatus as in claim 8, further comprising:~~

A load drive apparatus for switching a current supplied from a power source to a load by driving switching means, which has a switching device and a control unit for controlling a switching operation of the switching device, the load drive apparatus comprising:

a power source terminal connected to a power source side of the power source;

a ground terminal connected to a ground side of the power source;

a voltage supply line connected to the power source terminal to supply a voltage to the switching device and the control unit;

a ground line connecting the switching device and the control unit to the ground terminal;

an input terminal provided so that an input signal is inputted from an external side and the switching means controls ON and OFF conditions of the switching device based on the input signal applied to the input terminal;

the control unit has a first comparator to compare the input signal applied to the input terminal and a predetermined voltage preset with the voltage of the power source;

the first comparator outputs a control signal to turn off the switching device when the input signal applied to the input terminal is higher than the predetermined voltage;

a second resistor connected between the input terminal and the power source terminal;

and

a second capacitor connected between the input terminal and the ground terminal,

wherein a time constant of the second resistor and the capacitor is set so that the input signal applied to the input terminal rises faster than a predetermined voltage which is caused to rise with a flyback voltage applied to the voltage supply line when the switching device is turned off.

10. (Currently amended) ~~The load drive apparatus as in claim 8, further comprising:~~

Serial No. 09/824,763

A load drive apparatus for switching a current supplied from a power source to a load by driving switching means, which has a switching device and a control unit for controlling a switching operation of the switching device, the load drive apparatus comprising:

a power source terminal connected to a power source side of the power source;

a ground terminal connected to a ground side of the power source;

a voltage supply line connected to the power source terminal to supply a voltage to the switching device and the control unit;

a ground line connecting the switching device and the control unit to the ground terminal;

an input terminal provided so that an input signal is inputted from an external side and the switching means controls ON and OFF conditions of the switching device based on the input signal applied to the input terminal;

the control unit has a first comparator to compare the input signal applied to the input terminal and a predetermined voltage preset with the voltage of the power source;

the first comparator outputs a control signal to turn off the switching device when the input signal applied to the input terminal is higher than the predetermined voltage;

a second resistor connected between the input terminal and the power source terminal;

and

a second capacitor connected between the input terminal and the power source terminal.

11. ~~(Currently amended) The load drive apparatus as in claim 7, further comprising:~~

A load drive apparatus for switching a current supplied from a power source to a load by driving switching means, which has a switching device and a control unit for controlling a switching operation of the switching device, the load drive apparatus comprising:

a power source terminal connected to a power source side of the power source;

a ground terminal connected to a ground side of the power source;

a voltage supply line connected to the power source terminal to supply a voltage to the switching device and the control unit;

a ground line connecting the switching device and the control unit to the ground terminal;

Serial No. 09/824,763

an input terminal provided so that an input signal is inputted from an external side and the switching means controls ON and OFF conditions of the switching device based on the input signal applied to the input terminal;

the control unit has a first comparator to compare the input signal applied to the input terminal and a predetermined voltage preset with the voltage of the power source;

the first comparator outputs a control signal to turn off the switching device when the input signal applied to the input terminal is higher than the predetermined voltage; and

a one-shot multivibrator for maintaining an OFF condition of the switching device for a predetermined period when a control signal is outputted from the first comparator to turn off the switching device.

12. (Currently amended) ~~The load drive apparatus as in claim 7, further comprising:~~

A load drive apparatus for switching a current supplied from a power source to a load by driving switching means, which has a switching device and a control unit for controlling a switching operation of the switching device, the load drive apparatus comprising:

a power source terminal connected to a power source side of the power source;

a ground terminal connected to a ground side of the power source;

a voltage supply line connected to the power source terminal to supply a voltage to the switching device and the control unit;

a ground line connecting the switching device and the control unit to the ground terminal;

an input terminal provided so that an input signal is inputted from an external side and the switching means controls ON and OFF conditions of the switching device based on the input signal applied to the input terminal;

the control unit has a first comparator to compare the input signal applied to the input terminal and a predetermined voltage preset with the voltage of the power source;

the first comparator outputs a control signal to turn off the switching device when the input signal applied to the input terminal is higher than the predetermined voltage; and

the control unit has a second comparator for comparing the voltage of the power source and a threshold voltage which is set to be lower than a flyback voltage applied to the voltage supply line when the switching device is turned off.

Serial No. 09/824,763

13. (Currently amended) ~~The load drive apparatus as in claim 7, further comprising:~~

A load drive apparatus for switching a current supplied from a power source to a load by driving switching means, which has a switching device and a control unit for controlling a switching operation of the switching device, the load drive apparatus comprising:

a power source terminal connected to a power source side of the power source;

a ground terminal connected to a ground side of the power source;

a voltage supply line connected to the power source terminal to supply a voltage to the switching device and the control unit;

a ground line connecting the switching device and the control unit to the ground terminal;

an input terminal provided so that an input signal is inputted from an external side and the switching means controls ON and OFF conditions of the switching device based on the input signal applied to the input terminal;

the control unit has a first comparator to compare the input signal applied to the input terminal and a predetermined voltage preset with the voltage of the power source;

the first comparator outputs a control signal to turn off the switching device when the input signal applied to the input terminal is higher than the predetermined voltage and the first comparator compares the input signal applied to the input terminal with a fixed voltage which does not change even with voltage change of the power source; and

the control unit has a second comparator for comparing the voltage of the power source and a threshold voltage which is set to be lower than a flyback voltage applied to the voltage supply line when the switching device is turned off, the second comparator outputs the control signal to turn off the switching device when the input signal applied to the input terminal is higher than the fixed voltage.

14. (Currently amended) ~~The load drive apparatus as in claim 1, wherein:~~

A load drive apparatus for switching a current supplied from a power source to a load by driving switching means, which has a switching device and a control unit for controlling a switching operation of the switching device, the load drive apparatus comprising:

a power source terminal connected to a power source side of the power source;

a ground terminal connected to a ground side of the power source;

Serial No. 09/824,763

a voltage supply line connected to the power source terminal to supply a voltage to the switching device and the control unit;

a ground line connecting the switching device and the control unit to the ground terminal;

the control unit includes an excessive-heat detection unit for detecting an excessive-heat condition of a chip on which the control unit is provided, and a latch for outputting a control signal to turn off the switching device when the excessive-heat detection unit detects the excessive-heat condition, whereby the latch maintains the control signal during a predetermined period.

15. (Original) The load drive apparatus as in claim 14, wherein:

the latch is comprised as a RS flip-flop provided with a set terminal, a reset terminal, a first NOR circuit and a second NOR circuit;

both input signal from the set terminal and an output signal from the second NOR circuit are inputted to the first NOR circuit, while both input signal from the reset terminal and an output signal from the first NOR circuit are inputted to the second NOR circuit; and

the RS flip-flop includes a third capacitor allocated between the output part of the first NOR circuit and the power source supply line, and a fourth capacitor allocated between the output part of the second NOR circuit and the ground line.

16. (Original) The load drive apparatus as in claim 14, wherein:

the latch is reset by a reset signal from a power-on reset unit; and

the power-on reset unit outputs the reset signal when the voltage of the voltage supply line becomes lower than the voltage when a load is shorted.

17. (New) The load drive apparatus as in claim 5, further comprising:

an input terminal provided so that an input signal is inputted from an external side and the switching means controls ON and OFF conditions of the switching device based on the input signal applied to the input terminal.

18. (New) The load drive apparatus as in claim 17, wherein:

Serial No. 09/824,763

the control unit has a first comparator to compare the input signal applied to the input terminal and a predetermined voltage preset with the voltage of the power source; and

the first comparator outputs a control signal to turn off the switching device when the input signal applied to the input terminal is higher than the predetermined voltage.

19. (New) The load drive apparatus as in claim 18, further comprising:

a second resistor connected between the input terminal and the power source terminal.

20. (New) The load drive apparatus as in claim 19, further comprising:

a second capacitor connected between the input terminal and the ground terminal,

wherein a time constant of the second resistor and the capacitor is set so that the input signal applied to the input terminal rises faster than a predetermined voltage which is caused to rise with a flyback voltage applied to the voltage supply line when the switching device is turned off.

21. (New) The load drive apparatus as in claim 19, further comprising:

a second capacitor connected between the input terminal and the power source terminal.

22. (New) The load drive apparatus as in claim 18, further comprising:

a one-shot multivibrator for maintaining an OFF condition of the switching device for a predetermined period when a control signal is outputted from the first comparator to turn off the switching device.

23. (New) The load drive apparatus as in claim 18, wherein:

the control unit has a second comparator for comparing the voltage of the power source and a threshold voltage which is set to be lower than a flyback voltage applied to the voltage supply line when the switching device is turned off.

24. (New) The load drive apparatus as in claim 19, wherein:

the first comparator compares the input signal applied to the input terminal with a fixed voltage which does not change even with voltage change of the power source; and

Serial No. 09/824,763

the second comparator outputs the control signal to turn off the switching device when the input signal applied to the input terminal is higher than the fixed voltage.

25. (New) The load drive apparatus as in claim 5, wherein:

the control unit includes an excessive-heat detection unit for detecting an excessive-heat condition of a chip on which the control unit is provided, and a latch for outputting a control signal to turn off the switching device when the excessive-heat detection unit detects the excessive-heat condition, whereby the latch maintains the control signal during a predetermined period.

26. (New) The load drive apparatus as in claim 24, wherein:

the latch is comprised as a RS flip-flop provided with a set terminal, a reset terminal, a first NOR circuit and a second NOR circuit;

both input signal from the set terminal and an output signal from the second NOR circuit are inputted to the first NOR circuit, while both input signal from the reset terminal and an output signal from the first NOR circuit are inputted to the second NOR circuit; and

the RS flip-flop includes a third capacitor allocated between the output part of the first NOR circuit and the power source supply line, and a fourth capacitor allocated between the output part of the second NOR circuit and the ground line.

27. (New) The load drive apparatus as in claim 24, wherein:

the latch is reset by a reset signal from a power-on reset unit; and

the power-on reset unit outputs the reset signal when the voltage of the voltage supply line becomes lower than the voltage when a load is shorted.

28. (New) The load drive apparatus as in claim 14, wherein:

the voltage supply line connected to the power source terminal is used in common to both of the control unit and the switching device; and

the ground line connected to the ground terminal is used in common to both of the control unit and the switching device.

29. (New) The load drive apparatus as in claim 14, wherein:

Serial No. 09/824,763

the switching means includes a plurality of parallel-connected switching circuits, each of which has the switching device and the control unit, to drive in parallel the plurality of switching circuits;

the voltage supply line is connected in common to the control unit and the switching device of each of the switching circuits; and

the ground line is connected in common to the control unit and the switching device of each of the switching circuits.

30. (New) The load drive apparatus as in claim 14, wherein:

the switching means includes a plurality of parallel-connected switching circuits, each of which has the switching device and the control unit, to drive in parallel the plurality of switching circuits;

the voltage supply line is connected to the power source terminal to supply the voltage to the control unit and the switching device of each of the switching circuits; and

the ground line is connected to the ground terminal, and the control unit and the switching device of each of the switching circuits.

31. (New) The load drive apparatus as in claim 14, further comprising:

a first capacitor connected between the power source terminal and the ground terminal; and

a first resistor connected in series with the first capacitor.

32. (New) The load drive apparatus as in claim 14, further comprising:

an input terminal provided so that an input signal is inputted from an external side and the switching means controls ON and OFF conditions of the switching device based on the input signal applied to the input terminal.

33. (New) The load drive apparatus as in claim 32, wherein:

the control unit has a first comparator to compare the input signal applied to the input terminal and a predetermined voltage preset with the voltage of the power source; and

Serial No. 09/824,763

the first comparator outputs a control signal to turn off the switching device when the input signal applied to the input terminal is higher than the predetermined voltage.

34. (New) The load drive apparatus as in claim 33, further comprising:

a second resistor connected between the input terminal and the power source terminal.

35. (New) The load drive apparatus as in claim 34, further comprising:

a second capacitor connected between the input terminal and the ground terminal,
wherein a time constant of the second resistor and the capacitor is set so that the input signal applied to the input terminal rises faster than a predetermined voltage which is caused to rise with a flyback voltage applied to the voltage supply line when the switching device is turned off.

36. (New) The load drive apparatus as in claim 34, further comprising:

a second capacitor connected between the input terminal and the power source terminal.

37. (New) The load drive apparatus as in claim 33, further comprising:

a one-shot multivibrator for maintaining an OFF condition of the switching device for a predetermined period when a control signal is outputted from the first comparator to turn off the switching device.

38. (New) The load drive apparatus as in claim 33, wherein:

the control unit has a second comparator for comparing the voltage of the power source and a threshold voltage which is set to be lower than a flyback voltage applied to the voltage supply line when the switching device is turned off.

39. (New) The load drive apparatus as in claim 33, wherein:

the first comparator compares the input signal applied to the input terminal with a fixed voltage which does not change even with voltage change of the power source; and

the second comparator outputs the control signal to turn off the switching device when the input signal applied to the input terminal is higher than the fixed voltage.